Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

ALASKA OREGON WASHINGTON

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

USDA FOREST SERVICE RESEARCH NOTE

PNW-268 January 1976

SILVICULTURAL AND DIRECT CONTROL OF MOUNTAIN PINE BEETLE IN SECOND-GROWTH PONDEROSA PINE

Charles Sartwell, *Insect Ecologist*

Forestry Sciences Laboratory,
Pacific Northwest Forest and Range Experiment Station,
Forest Service,
U.S. Department of Agriculture, Corvallis, Oregon.

and

Robert E. Dolph, Jr., *Supervisory Entomologist*

Pacific Northwest Regional Office, Forest Service,
U.S. Department of Agriculture, Portland, Oregon.

ABSTRACT

In the first 5 years after treatment, silvicultural thinning reduced killing of *Pinus ponderosa* poletimber by *Dendroctonus ponderosae* by more than 90 percent and led to positive net stand growth in an eastern Oregon test. The felling and burning of infested trees also substantially reduced tree mortality caused by mountain pine beetle; even so, the treated stand declined in the post-treatment period due to damage by other agents. The practical effect of direct control in combination with thinning was no greater than that obtained by thinning alone.

KEYWORDS: Insect damage control (forest), Ponderosa pine, Pinus ponderosa, mountain pine beetle, Dendroctonus ponderosae, thinnings, fire use.

In the Northwestern United States, mountain pine beetle, *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae), is the major pest of second-growth ponderosa pine, *Pinus ponderosa* Lawson. Outbreaks occur predominantly in poletimber, where stand density is high for a given site (Sartwell 1971). Beetle-killed trees, including ones with dominant positions in the forest canopy, characteristically have grown very slowly for more than 10 years prior to being attacked (Eaton 1941). Also, they have short crowns, typically less than one-third of tree height (Sartwell 1971). This evidence indicates that low tree vigor due to intensive between-tree competition underlies the occurrence of beetle outbreaks, and suggests silvicultural thinning as an approach to outbreak prevention.

Applied control efforts traditionally have aimed at the direct suppression of beetle populations by the felling and burning or insecticidal treatment of infested trees. However, the period of reduced tree killing obtained by direct control of *D. ponderosae* in *P. ponderosa* has not been documented.

We report here the 5-year results of a continuing study of indirect, direct, and combined methods for control of mountain pine beetle in second-growth ponderosa pine. Our objectives are to determine the degree and duration of reduced tree killing achieved by (1) different intensities of thinning, (2) felling and burning of infested trees, and (3) the treatment which combines suppressing the beetle population and then thinning the stand.

METHODS

The study area is located in the Sumpter Valley, about 25 km (15 mi) southwest of Baker, Oregon. The virgin pine forest here was heavily logged during the late 19th and early 20th centuries. A blanket of second-growth ponderosa pine now generally covers the lower slopes from the edge of the valley floor at 1200-m (4,000-ft) elevation to where the terrain steepens sharply at about 1500 m (5,000 ft). Severe tree killing by mountain pine beetle had occurred in the valley and vicinity for several years before the beginning of our test. In 1966, about 8000 ha (20,000 acres) were seriously infested.

The stand occupying the test site is nearly pure pine, with occasional pockets of western larch, *Larix occidentalis* Nuttall, and a few widely scattered Douglas-fir, *Pseudotsuga menziesii* (Mirbel) Franco. Stand structure is essentially even aged, and most trees were 10- to 20-cm (4- to 8-in) d.b.h. and about 55 years old when treatments were applied in 1967. Dominant trees then averaged about 12 m (40 ft) in height, indicating growth quality of the land rates as about Site Index 65 or Site Class V in the classification of Meyer (1961).

Experimental design consists of 10 plots, each covering about 10 ha (25 acres); these are grouped into two blocks (fig. 1). On the northern block, the beetle population was suppressed by the felling and burning of all infested trees during the late winter and early spring. Treated trees averaged 8.6/ha (3.5/acre). No direct control was applied against the beetle population in the southern block.

Plot assignments were randomly made within each block to obtain a double replication of these treatments: (a) unthinned check, (b) 3.5- by 3.5-m (12- by 12-ft) spacing between residual trees, (c) 4.5- by 4.5-m (15- by 15-ft), (d) 5.5- by 5.5-m (18- by 18-ft), and (e) 6.5- by 6.5-m (21- by 21-ft). These approximate

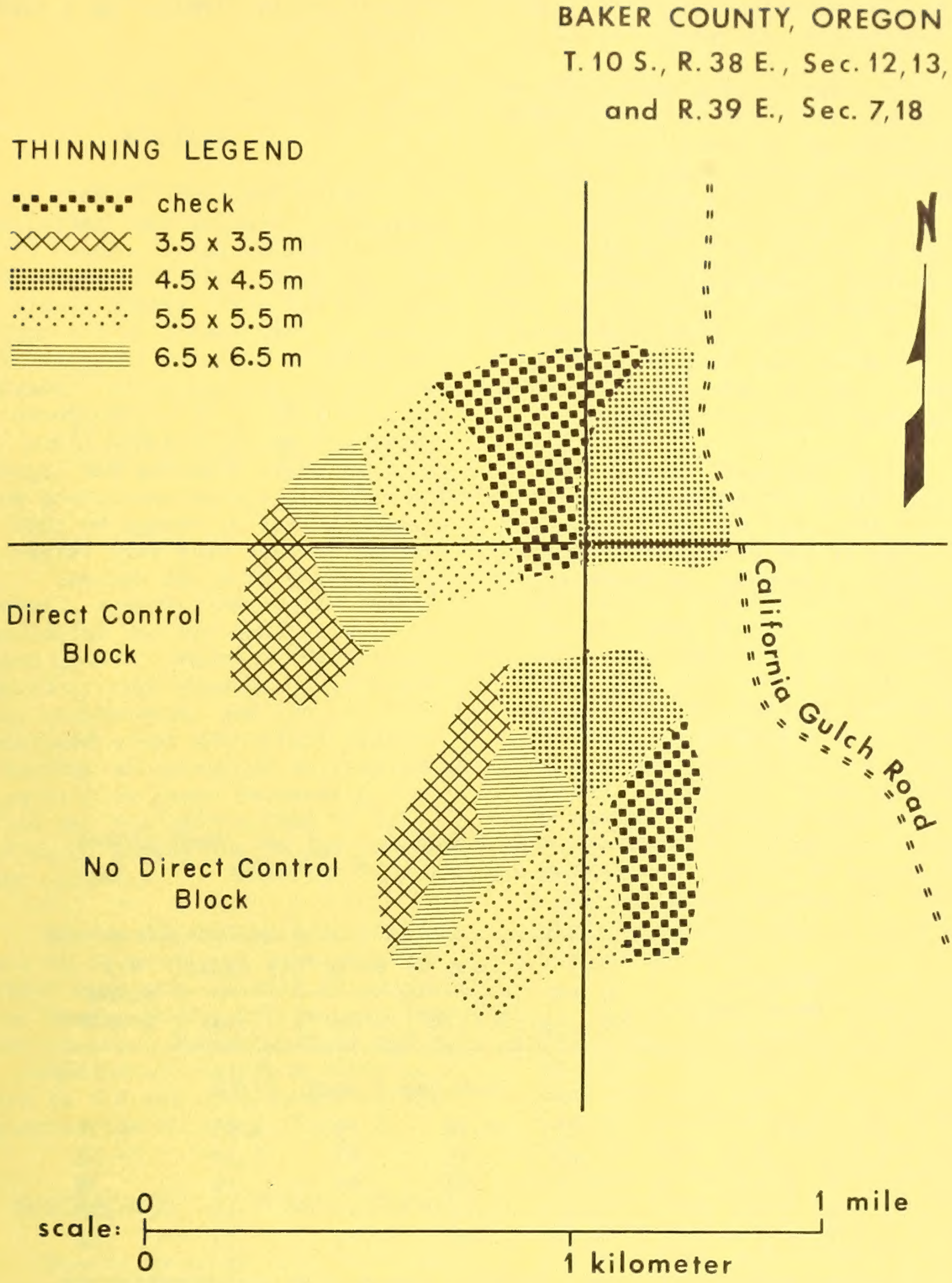

Figure 1.--Map of Sumpter Valley study area.

spacings were achieved by cutting the smaller trees in a way Smith (1962) referred to as a radical application of the low thinning principle. All cut trees were left where felled.

The point samping method (Beers and Miller 1964) was used to collect live stand and mortality data from 20 permanent sample points on each plot. The first live stand cruise was made in September 1967, the second in August 1972, and others are planned at 5-year intervals. We expect parts of the study to run for at least 20 years. Mortality cruises are conducted each year in late summer. Tallied dead trees are marked as to year and cause of death.

A full replicate of this test was installed contemporaneously in another area; but due to a misunderstanding, it was partially logged a year after treatment and rendered unsuitable for our experiment. Thus, lacking adequate replication for statistical analysis, we present our Sumpter Valley findings as a case history.

RESULTS

During the first 5 years after treatment, thinning substantially reduced tree mortality caused by mountain pine beetle and also led to positive net stand growth (table 1). Damage by this insect on the unthinned plots was at least 10 times greater than on the thinned plots. Nearly all tree killing by *Dendroctonus ponderosae* on the thinned plots occurred where thinning was lightest. The more heavily thinned plots were virtually free of damage by this beetle; indeed, they were rather free of mortality from all causes.

Table 1--*Cumulative tree mortality and net stand growth during 5 years after thinning*

Thinning treatment	1967 stand density	Loss by mortality cause			Net stand growth
		Beetle	Other	Total	
	Stem basal area, m^2/ha				
Unthinned	39.88	2.70	2.19	4.89	-4.78
3.5 by 3.5 m	26.87	.75	.63	1.38	-.63
4.5 by 4.5 m	19.74	.06	.06	.12	.75
5.5 by 5.5 m	14.22	.00	.17	.17	.69
6.5 by 6.5 m	8.06	.00	.17	.17	.52

Felling and burning of infested trees in 1967 substantially reduced tree killing by *D. ponderosae* in the 5 years after treatment (table 2).

Table 2--*Comparison of cumulative silvicultural and direct control effects 5 years after treatment*

Treatment	Loss by mortality cause		
	Beetle	Other	Total
	Stem basal area, m^2/ha		
Check	5.30	2.53	7.83
Direct control only	.11	1.84	1.95
Thinning only	.11	.35	.46
Direct control and thinning	.29	.17	.46

However, suppression of the beetle population did not lead to positive stand growth. Moderate mortality caused by root disease, snow breakage, competition, and *Ips pini* (Say) continued after the direct control treatment and resulted in stem basal area of live trees decreasing from 41.44 to 39.48 m^2/ha (180 to 172 ft^2/acre) during the 5-year posttreatment period.

Direct control applied preliminary to thinning had no measurable effect upon tree killing by mountain pine beetle in the 5-year posttreatment period. Thinning alone reduced *D. ponderosae*-caused mortality as much as did the combination of direct control plus thinning (table 2).

DISCUSSION AND CONCLUSIONS

Nearly 50 years ago, Munns and Colville (1928) remarked that no research had been done toward "determining the kind, quality and amount of thinning that should be given young 2nd-growth pine stands to make them fairly free from insect attach." Subsequently, there have been some advances in the silvicultural control of insects affecting mature trees. Most widely applied is the selective logging of old-growth ponderosa pine based on the scheme of Salman and Bongberg (1942) for rating tree susceptibility to attack by western pine beetle, *D. brevicomis* LeConte. However, thinning experiments to prevent insect damage in sapling and poletimber stands have been rare, even though authors of nearly all standard forest entomology textbooks mention the potential of thinning in pest management.

Our results from Sumpter Valley indicate that thinning is more than merely a potential means of dealing with mountain pine beetle in second-growth ponderosa pine. At least for the term of 5 years, its pest management value has been demonstrated on a near-operational scale. Thus, the main practical questions remaining are: (1) How many years will thinning prevent serious damage by the beetle? and (2) Do our results apply elsewhere in western North America? Also to be explained more fully is why thinning reduces the effect of this insect on ponderosa pine stands.

We expect to continue our study for at least 20 years to determine duration of effectiveness for the different intensities of thinning. Evidence offers little reason to choose among the heavier thinnings, but it indicates the 3.5- by 3.5-m (12- by 12-ft) spacing will not have practical benefits, either entomologically or silviculturally, when applied after a beetle outbreak has begun. Light thinnings might be effective if made earlier in stand development than in our test, as Barrett (1968) obtained a good growth response with a 4.0- by 4.0-m (13- by 13-ft) thinning in a 47-year-old stand on Site Class V land in northern Washington. However, stand density at the time of treatment was much lower (stem basal area, 28 m^2/ha or 123 ft^2/acre) than in our test area (40 m^2/ha or 173 ft^2/acre.) Also, there was little beetle activity in the area when Barrett began his study.

Existing techniques for projecting stand development, such as those of Myers (1971) and Stage (1973), can provide interim answers about the duration of effectiveness for thinning as a pest control measure. When beetle population models are developed, they can be coupled with stand models to help determine probable effectiveness of treatment under various circumstances. However, knowledge of the practical value of thinning for management of mountain pine beetle in different areas and under various stand conditions must come primarily from field experiments and operational experience. A thinning test was begun in Montana in 1971, and another in the Black Hills of South Dakota is being contemplated. Although early results from Montana strongly support our findings, we urge establishment of tests in additional areas.

As to why thinning reduces tree killing by mountain pine beetle, we hypothesize that the removal of competing neighbors allows residual trees to increase their resistance to beetle attack. There is abundant silvicultural evidence that thinning improves the growth rate of individual trees, and we assume this sign of improved tree vigor is accompanied by a corresponding increase in attack resistance. After some years, we suggest, competition between trees will resume and ultimately will allow another beetle outbreak to occur. Thus, we also hypothesize that the heavier the thinning treatment the greater the period of reduced tree killing. Clearly, there is a need for physiological studies to determine how thinning affects tree resistance. Also needed are studies to identify the site resource for which between-tree competition is greatest.

An alternative or perhaps supplementary hypothesis, suggested by the work of Gara and Coster (1968) with *D. frontalis* Zimmerman, is that increasing the distance between trees reduces the probability that mass aggregation of beetles to one tree will result in neighboring trees being attacked. Our test evidence gives us no reason to challenge this notion; however, in several areas of the Pacific Northwest, we have observed substantial tree killing by *D. ponderosae* in mixed stands, where the ponderosa pines were spaced fairly widely but were stressed by competition from intermingling trees of nonhost species. Probably some distance between trees will prevent group killing, but how much has not been determined for mountain pine beetle.

Inadequate replication prohibits strong conclusions about the direct control aspects of our test, but the results raise doubts about the practical benefits gained by killing beetles and their broods. The felling and burning of infested trees definitely reduced damage by the target pest during the 5-year posttreatment period. This finding agrees with operational experience that direct control is generally effective against *D. ponderosae* for about 3 to 7 years. However, as other mortality agents caused the stand to decline despite effective suppression of the beetle population, it is difficult to classify our direct control treatment as practically successful.

Possibly there are situations where the short-term effectiveness of direct control can be utilized in a stopgap action to provide time for a thinning program to be implemented. However, our findings suggest that suppression of a beetle population immediately prior to a scheduled thinning will not enhance overall control effectiveness: it merely increases treatment costs. Our findings are similar to those of J. W. Bongberg (see Miller and Keen 1960, p. 347-348), who found that a combination of direct and indirect methods was slightly more effective for control of *D. brevicomis* than a silvicultural method alone but not enough to justify the added costs.

LITERATURE CITED

Barrett, James W.
1968. Response of ponderosa pine pole stands to thinning. U.S. Dep. Agric. For. Serv., Res. Note PNW-77, 11 p. U.S. Dep. Agric., Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Beers, T. W., and C. I. Miller.
1964. Point sampling: research results, theory, and applications. Purdue Univ. Agric. Exp. Stn., Res. Bull. 786, 56 p.

Eaton, C. B.
1941. Influence of the mountain pine beetle on the composition of mixed pole stands of ponderosa pine and white fir. J. For. 39:710-713.

Gara, R. I., and J. E. Coster.
1968. Studies on the attack behavior of the southern pine beetle. III. Sequence of tree infestation within stands. Contrib. Boyce Thompson Inst. 24:77-86.

Meyer, W. H.
1961. Yield of even-aged stands of ponderosa pine. U.S. Dep. Agric., Tech. Bull. 630 (rev.), 59 p.

Miller, J. M., and F. P. Keen.
1960. Biology and control of the western pine beetle. U.S. Dep. Agric., Misc. Publ. 800, 381 p.

Munns, E. N., and Perkins Colville.
1928. Silvicultural practice in the control of forest insects. Trans. Fourth Int. Congr. Entomol. 2:333-341.

Myers, C. A.
1971. Field and computer procedures for managed-stand yield tables. U.S. Dep. Agric. For. Serv., Res. Pap. RM-79, 24 p. U.S. Dep. Agric., Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Salman, K. A., and J. W. Bongberg.
1942. Logging high-risk trees to control insects in the pine stands of northeastern California. J. For. 40:533-539.

Sartwell, Charles.
1971. Thinning ponderosa pine to prevent outbreaks of mountain pine beetle. *In* D. M. Baumgartner (ed.), Precommercial thinning of coastal and intermountain forests in the Pacific Northwest, p. 41-52. Wash. State Univ. Coop. Ext. Serv., Pullman.

Smith, D. M.
1962. The practice of silviculture. 7th ed. 578 p. John Wiley and Sons, Inc., New York and London.

Stage, A. R.
1973. Prognosis model for stand development. U.S. Dep. Agric. For. Serv., Res. Pap. INT-137, 32 p. U.S. Dep. Agric., Intermt. For. and Range Exp. Stn., Ogden, Utah.

* * * * *

GPO 995-392